

Claims

- [c1] An image display device comprising:
- (a) a reflective sheet having a prismatic inward surface and an opposed outward surface;
 - (b) an electrophoretic medium contacting the prismatic surface;
 - (c) a plurality of particles suspended in the electrophoretic medium; and
 - (d) means for applying a voltage across the electrophoretic medium to selectively move the particles closely adjacent the prismatic surface to frustrate total internal reflection at the prismatic surface of light rays passing through the reflective sheet,
- the electrophoretic medium having an index of refraction sufficiently smaller than the index of refraction of the reflective sheet that most of the light passing through the reflective sheet undergoes total internal reflection at the prismatic surface when the particles are not closely adjacent the prismatic surface,
- wherein the means for applying a voltage comprises a first electrode substantially conforming to the shape of the prismatic surface and a second electrode substantially conforming to the shape of the first electrode such that the gap between the first and second electrodes is of substantially constant width.
- [c2] An image display device according to claim 1 wherein the first electrode comprises a layer of conductive material disposed on the prismatic surface.
- [c3] An image display device according to claim 1 further comprising a rear support disposed on the opposed side of the electrophoretic medium from the reflective sheet, the rear support having a rear prismatic surface substantially conforming to the form of the prismatic surface on the reflective sheet, the second electrode being disposed on the rear prismatic surface.
- [c4] An image display device according to claim 1 wherein the prismatic inward surface has the form of the surface of a plurality of triangular prisms, each having a ridge and first and second surfaces, the first and second surfaces lying on opposed sides of the ridge and being of opposite inclination, the device

having a plurality of second electrodes each associated with one of the triangular prisms, each second electrode having a first section extending substantially parallel to the first surface of its associated prism and a second surface extending substantially parallel to the second surface of its associated prism, the first and second sections of each individual second electrode both being connected to a single conductor.

[c5] An image display device according to claim 4 further comprising a rear support disposed on the opposed side of the electrophoretic medium from the reflective sheet and carrying the second electrodes, the single conductor having the form of a via extending through the rear support.

[c6] An image display device according to claim 5 further comprising a transistor connected to the via.

[c7] An image display device comprising:

- (a) a reflective sheet having a prismatic inward surface and an opposed outward surface;
- (b) an electrophoretic medium contacting the prismatic surface;
- (c) a plurality of particles suspended in the electrophoretic medium; and
- (d) means for applying a voltage across the electrophoretic medium to selectively move the particles closely adjacent the prismatic surface to frustrate total internal reflection at the prismatic surface of light rays passing through the reflective sheet,

the electrophoretic medium having an index of refraction sufficiently smaller than the index of refraction of the reflective sheet that most of the light passing through the reflective sheet undergoes total internal reflection at the prismatic surface when the particles are not closely adjacent the prismatic surface,

wherein the electrophoretic medium and the plurality of particles are contained within a plurality of capsules.

[c8] An image display device according to claim 7 wherein the walls of the capsules have a refractive index which does not differ from the refractive index of the reflective sheet by more than about 0.3.

- [c9] An image display device according to claim 8 wherein the walls of the capsules have a refractive index which does not differ from the refractive index of the reflective sheet by more than about 0.2.
- [c10] An image display device according to claim 7 wherein the walls of the capsules have a thickness not greater than about 200 nm.
- [c11] An image display device according to claim 7 wherein the walls of the capsules have a thickness not greater than about 100 nm.
- [c12] An image display device according to claim 7 wherein the electrophoretic medium comprises a viscosity modifier.
- [c13] An image display device according to claim 12 wherein the viscosity modifier comprises a polymer having an intrinsic viscosity of η in the electrophoretic medium and being substantially free from ionic or ionizable groups in the electrophoretic medium, the polymer being present in the electrophoretic medium in a concentration of from about $0.5 \eta^{-1}$ to about $2.0 \eta^{-1}$.
- [c14] An image display device according to claim 12 wherein the viscosity modifier comprises a polyisobutylene.
- [c15] An image display device comprising:
 - (a) a reflective sheet having a prismatic inward surface and an opposed outward surface;
 - (b) an electrophoretic medium contacting the prismatic surface;
 - (c) a plurality of particles suspended in the electrophoretic medium; and
 - (d) means for applying a voltage across the electrophoretic medium to selectively move the particles closely adjacent the prismatic surface to frustrate total internal reflection at the prismatic surface of light rays passing through the reflective sheet,
 the electrophoretic medium having an index of refraction sufficiently smaller than the index of refraction of the reflective sheet that most of the light passing through the reflective sheet undergoes total internal reflection at the prismatic surface when the particles are not closely adjacent the prismatic surface,

wherein the electrophoretic medium comprises a viscosity modifier.

[c16] An image display device according to claim 15 wherein the viscosity modifier comprises a polymer having an intrinsic viscosity of η in the electrophoretic medium and being substantially free from ionic or ionizable groups in the electrophoretic medium, the polymer being present in the electrophoretic medium in a concentration of from about $0.5 \eta^{-1}$ to about $2.0 \eta^{-1}$.

[c17] An image display device according to claim 15 wherein the viscosity modifier comprises a polyisobutylene.

[c18] An image display device according to claim 15 wherein the viscosity modifier gels the electrophoretic medium.

[c19] An image display device comprising:

- (a) a reflective sheet having a prismatic inward surface and an opposed outward surface;
- (b) an electrophoretic medium contacting the prismatic surface;
- (c) a plurality of particles suspended in the electrophoretic medium; and
- (d) means for applying a voltage across the electrophoretic medium to selectively move the particles closely adjacent the prismatic surface to frustrate total internal reflection at the prismatic surface of light rays passing through the reflective sheet,

the electrophoretic medium having an index of refraction sufficiently smaller than the index of refraction of the reflective sheet that most of the light passing through the reflective sheet undergoes total internal reflection at the prismatic surface when the particles are not closely adjacent the prismatic surface,

wherein the particles comprise a pigment bearing a polymer coating.

[c20] An image display device according to claim 19 wherein the pigment comprises carbon black.

[c21] An image display device according to claim 20 wherein the carbon black particles have from about 1 to about 25 per cent by weight of the carbon black of the polymer chemically bonded to, or cross-linked around, the carbon black

particles.

- [c22] An image display device according to claim 19 wherein the polymer coating comprises at least one arsenic-containing monomer.
- [c23] An image display device according to claim 19 wherein the polymer coating comprises at least one fluorinated monomer.
- [c24] An image display device comprising:
- (a) a reflective sheet having a prismatic inward surface and an opposed outward surface;
 - (b) an electrophoretic medium contacting the prismatic surface;
 - (c) a plurality of particles suspended in the electrophoretic medium; and
 - (d) means for applying a voltage across the electrophoretic medium to selectively move the particles closely adjacent the prismatic surface to frustrate total internal reflection at the prismatic surface of light rays passing through the reflective sheet,
- the electrophoretic medium having an index of refraction sufficiently smaller than the index of refraction of the reflective sheet that most of the light passing through the reflective sheet undergoes total internal reflection at the prismatic surface when the particles are not closely adjacent the prismatic surface,
- wherein the volume fraction of the particles in the electrophoretic medium is at least about 50 per cent.
- [c25] An image display device according to claim 24 wherein the volume fraction of the particles in the electrophoretic medium is at least about 70 per cent.
- [c26] An image display device comprising:
- (a) a reflective sheet having a prismatic inward surface and an opposed outward surface;
 - (b) an electrophoretic medium contacting the prismatic surface;
 - (c) a plurality of particles suspended in the electrophoretic medium; and
 - (d) means for applying a voltage across the electrophoretic medium to selectively move the particles closely adjacent the prismatic surface to

frustrate total internal reflection at the prismatic surface of light rays passing through the reflective sheet,
the electrophoretic medium having an index of refraction sufficiently smaller than the index of refraction of the reflective sheet that most of the light passing through the reflective sheet undergoes total internal reflection at the prismatic surface when the particles are not closely adjacent the prismatic surface,
wherein at least some of the plurality of particles are attached to the reflective sheet by flexible filaments.

[c27] An image display device according to claim 26 wherein the flexible filaments are formed of a material which is solvated by the electrophoretic medium.

[c28] An image display device comprising:
(a) a reflective sheet having a prismatic inward surface and an opposed outward surface;
(b) an electrophoretic medium contacting the prismatic surface;
(c) a plurality of particles suspended in the electrophoretic medium; and
(d) means for applying a voltage across the electrophoretic medium to selectively move the particles closely adjacent the prismatic surface to frustrate total internal reflection at the prismatic surface of light rays passing through the reflective sheet,
the electrophoretic medium having an index of refraction sufficiently smaller than the index of refraction of the reflective sheet that most of the light passing through the reflective sheet undergoes total internal reflection at the prismatic surface when the particles are not closely adjacent the prismatic surface,
wherein the plurality of particles vary in electrophoretic mobility, at least one of the particles having an electrophoretic mobility which is at least twice that of another of the particles.

[c29] An image display device according to claim 28 wherein at least one of the particles has an electrophoretic mobility which is at least five times that of another of the particles.

- [c30] An image display device comprising:
- (a) a reflective sheet having a prismatic inward surface and an opposed outward surface;
 - (b) an electrophoretic medium contacting the prismatic surface;
 - (c) a plurality of particles suspended in the electrophoretic medium; and
 - (d) means for applying a voltage across the electrophoretic medium to selectively move the particles closely adjacent the prismatic surface to frustrate total internal reflection at the prismatic surface of light rays passing through the reflective sheet,
- the electrophoretic medium having an index of refraction sufficiently smaller than the index of refraction of the reflective sheet that most of the light passing through the reflective sheet undergoes total internal reflection at the prismatic surface when the particles are not closely adjacent the prismatic surface,
- wherein the plurality of particles are selected from substantially spherical particles having diameters in the range of about 200 to about 300 nm, oblate ellipsoids and spheroids, and flat plates and prisms having an aspect ratio of at least about 3:1.
- [c31] An image display device according to claim 30 wherein the plurality of particles are selected from metal flakes having an aspect ratio of at least about 5:1.
- [c32] An image display device comprising:
- (a) a reflective sheet having a prismatic inward surface and an opposed outward surface;
 - (b) an electrophoretic medium contacting the prismatic surface;
 - (c) a plurality of particles suspended in the electrophoretic medium; and
 - (d) means for applying a voltage across the electrophoretic medium to selectively move the particles closely adjacent the prismatic surface to frustrate total internal reflection at the prismatic surface of light rays passing through the reflective sheet,
- the electrophoretic medium having an index of refraction sufficiently smaller than the index of refraction of the reflective sheet that most of the light passing through the reflective sheet undergoes total internal

reflection at the prismatic surface when the particles are not closely adjacent the prismatic surface,

wherein the prismatic surface is provided with an electrode and a layer of a substantially insulating material having a low refractive index covering the electrode.

[c33] An image display device according to claim 32 wherein the low refractive index material comprises magnesium fluoride.

[c34] An image display device comprising:

- (a) a reflective sheet having a prismatic inward surface and an opposed outward surface;
- (b) an electrophoretic medium contacting the prismatic surface;
- (c) a plurality of particles suspended in the electrophoretic medium;
- (d) means for applying a voltage across the electrophoretic medium to selectively move the particles closely adjacent the prismatic surface to frustrate total internal reflection at the prismatic surface of light rays passing through the reflective sheet;
- (e) a rear support disposed on the opposed side of the electrophoretic medium from the reflective sheet; and
- (f) a plurality of cross-walls extending from the reflective sheet to the rear support and separating the electrophoretic medium into a plurality of cells isolated from one another by the cross-walls,

the electrophoretic medium having an index of refraction sufficiently smaller than the index of refraction of the reflective sheet that most of the light passing through the reflective sheet undergoes total internal reflection at the prismatic surface when the particles are not closely adjacent the prismatic surface.

[c35] An image display device comprising:

- (a) a reflective sheet having a prismatic inward surface and an opposed outward surface;
- (b) an electrophoretic medium contacting the prismatic surface;
- (c) a plurality of particles suspended in the electrophoretic medium; and

(d) means for applying a voltage across the electrophoretic medium to selectively move the particles closely adjacent the prismatic surface to frustrate total internal reflection at the prismatic surface of light rays passing through the reflective sheet,

the electrophoretic medium comprising first and second phases, the first phase wetting the prismatic surface while the second does not, whereby a layer of the first phase is formed covering and substantially conforming to the prismatic surface, the first phase having an index of refraction sufficiently smaller than the index of refraction of the reflective sheet that most of the light passing through the reflective sheet undergoes total internal reflection at the prismatic surface when the particles are not closely adjacent the prismatic surface.

[c36] An image display device according to claim 35 wherein the particles only move within the first phase.

[c37] An image display device according to claim 35 wherein the particles move between two phases but the free energy of the particles in the second phase differs from their free energy in the first phase, such that movement of the particles between the two phases provides a threshold for switching of the device.

[c38] An image display device comprising:

- (a) a reflective sheet having a prismatic inward surface and an opposed outward surface;
- (b) an electrophoretic medium contacting the prismatic surface;
- (c) a plurality of particles suspended in the electrophoretic medium; and
- (d) means for applying a voltage across the electrophoretic medium to selectively move the particles closely adjacent the prismatic surface,

wherein the particles comprise at least one light-scattering or light-absorptive center disposed within a light transmissive matrix, whereby, when the particles are disposed closely adjacent the prismatic surface, most of the light passing through the reflective sheet passes into the particles and is scattered or absorbed by the light-scattering or light-absorptive center.